CURRICULUM VITAE

Dr. MICHAEL (MISHA) CHERTKOV
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EDUCATION

1996 Ph.D. Physics, Weizmann Institute of Science
1990 M.Sc. Physics, Novosibirsk State University

EMPLOYMENT

2002- Full Term Technical Staff Member, Theoretical Division, Los Alamos NL
1999-2001 J.R. Oppenheimer Fellow, Theoretical Division, Los Alamos NL
1996-99 R.H. Dicke Fellow, Department of Physics, Princeton University
1993-96 Research Assistant, Weizmann Institute of Science
1990-92 Junior Researcher, Budker Institute, Novosibirsk

AWARDS and ADJUNCT AFFILIATIONS

2010 Visiting Scholar (Aston, UK)
2008- Visiting Researcher (NM Consortium)
2007 Weston Visiting Professor (Weizmann Institute)
2007 Visiting Scholar (Joint Theory Institute at U of Chicago and ANL)
2004 CNRS Visiting Scholar (Nonlinear Institute, Nice)
1999 J.R. Oppenheimer Fellowship at LANL
1996-99 Consultant (Bell Laboratories, Lucent Technologies)
1996 R.H. Dicke Fellowship at Princeton (Physics Department)
1996 Prize of the Feinberg Graduate School
1995 Prize of the Charles Clore Israel Foundation

WORKSHOPS ORGANIZED (2007–)

08/2009 Workshop on Linear Programming and Message-Passing Approaches to High-Density Parity-Check Codes and High-Density Graphical Models (Tel-Aviv University, Israel)
08/2009 Physics of Algorithms (CNLS, Santa Fe)
05/2009 The Pioneering Science of Robert H. Kraichnan (CNLS, Santa Fe)
03/2008 Classical and Quantum Information Theory (CNLS, Santa Fe)
05/2007 Algorithms, Inference and Statistical Physics (CNLS, Santa Fe)

ADVISED POSTDOCS and FELLOWS

2009- Shrinivas Kudekar (Ph.D. EPFL; NMC postdoc) - *Information/Coding Theory*
2009- Konstantin Turitsyn (Ph.D. Landau Inst.; J.R. Oppenheimer Fellowship) - *Statistical Physics*
2008- Jason Johnson (Ph.D. MIT; Director's Fellowship) - *Computer Science, Machine Learning*
2008- Lenka Zdeborova (Ph.D. Orsay; Director's Fellowship) - *Statistical Physics, Combinatorial Optimization*
2006-2008 Nandakishore Santhi (Staff Member at CCS-3/LANL)- *Information/Coding Theory*
2006-2008 Razvan Teodorescu (Assistant Professor at University of South Florida) - *Mathematical/Statistical Physics*
2005-2007 Colm Connaughton (Lecturer at U of Warwick, UK) - *Statistical Physics, Turbulence*
2004-2006 Misha Stepanov (Assistant Professor at UA, Tucson) - *Statistical Physics, Theory of Error-Correction*
2002-2004 Yeo-Jin Chung (Assistant Professor at SMU, Dallas) - *Applied Mathematics, Fiber Optics Communications*
2001-2004 Avner Peleg (Assistant Professor at SUNY, Buffalo) - *Applied Mathematics, Fiber Optics Communications*

RESEARCH GRANTS (PI)

2011-2013 Network Adaptability from WMD Disruption and Cascading Failures (DTRA)$\approx 360K\$$/year
2010-2012 Optimization and Control Theory for Smart Grids (LDRD/DR at LANL)$\approx 1.65M\$$/year
2009-2011 Coding, Detection, and Inference in Multiple Dimensions, (UCOP LANL-UCSD) $\approx 180K\$$/year
2008-2010 Harnessing Statistical Physics for Computing and Communication (NSF via NM Consortium, EMT/MISC: Collaborative Research with MIT & Cornell)$\approx 130K\$$/year
2007-2009 Physics of Algorithms (LDRD/DR at LANL)$\approx 1.5M\$$/year
2006-2008 Novel physics inspired approach to error-correction (LDRD/ER at LANL) $\approx 300K\$$/year
2006-2007 Prediction of Mixing Induced by Rayleigh-Taylor Instability (WSR at LANL)$\approx 200K\$$/year
2001-2003 Statistical Physics of Fiber Optics Communications (LDRD/ER at LANL) $\approx 190K\$$/year

INVITED PRESENTATIONS at CONFERENCES and WORKSHOPS (2010–)

11/2010 Turbulence and Mixing, Eilat, Israel
10/2010 DIMACS workshop on Algorithmic Decision Theory for the Smart Grid, Rutgers
08/2010 Information Theory Workshop 2010, Dublin, Ireland
03/2010 Statistical Physics of Complexity, Optimization and Biological information, Les Houches, France

02/2010 Workshop on the Frontiers of Controls, Games and Network Science, UoT, Austin
02/2010 The 2010 Information Theory and Application Workshop, ITA, UCSD

FIELDS OF INTEREST:

Theoretical, Statistical and Mathematical Physics, Applied Mathematics, Hydrodynamics, Optics, Classical and Quantum Information Theory, Error-Correction Theory, Computer Science, Queuing Theory, Power Grid

PATENT

U.S. Patent 6701050, issued March 2, 2004: Methods and Optical Fibers that decrease pulse degradation resulting from random chromatic dispersion, Co-author: I. Gabitov.

LIST OF PUBLICATIONS

95. A Majorization-Minimization Approach to Design of Power Transmission Networks, submitted to 49th IEEE Conference on Decision and Control, co-author J. Johnson.

94. Non-Equilibrium Statistical Physics of Currents in Queuing Networks, arXiv:1001.5454, submitted to Journal of Statistical Physics, co-authors: V. Chernyak, D.A. Goldberg, and K. Turitsyn.

93. Worst Configurations (Instantons) for Compressed Sensing over Reals, arxiv:1001.5113, to appear in proceedings of ISIT 2010 Meeting, co-authors: S. Chillapagari, B. Vasic.

92. Distributed control of reactive power flow in a radial distribution circuit with high photovoltaic penetration, arxiv:0912.3281, to appear in proceedings of IEEE PES General Meeting 2010, co-authors: K. Turitsyn, P. Sulc, S. Backhaus.

91. Belief Propagation and Loop Calculus for Permanent of a Non-Negative Matrix, arxiv:0911.1419, co-author: Y. Watanabe.

90. Inference in particle tracking experiments by passing messages between images, PNAS 10.1073/pnas.0910994107, arxiv:0909.4256, co-authors L. Kroc, F. Krzakala, M. Vergassola, L. Zdeborova.

89. Universal Shape of Coherent Vortices Generated by Two-Dimensional Turbulence, Phys. Rev. E **81**, 015302(R) (2010), arXiv:0909.1575,co-authors I. Kolokolov and V. Lebedev.

88. Non-Equilibrium Thermodynamics and Topology of Currents, Journal of Statistical Physics `http://www.springerlink.com/content/17740348qh5j03m7/`, arXiv:0907.3481, co-authors: V. Chernyak, S. Malinin and R. Teodorescu.

87. Counting Independent Sets Using the Bethe Approximation, to appear in SIAM Journal on Discrete Math, `http://www-math.mit.edu/~jinwoos/submit_bp.pdf`, co-authors: J. Shin, V. Chandrasekaran, D. Gamarnik and D. Shah.

86. Message Passing for Integrating and Assessing Renewable Generation in a Redundant Power Grid, proceedings of HICSS-43, Jan. 2010, arXiv:0909.2358, co-authors: L. Zdeborova and S. Backhaus.

85. Message Passing for Optimization and Control of Power Grid: Toy Model of Distribution with Ancillary Lines, arxiv:0904.0477, Phys. Rev. E **80**, 046112 (2009), `http://link.aps.org/abstract/PRE/v80/e046112`, co-authors: L. Zdeborova and A. Decelle.

84. Orbit-Product Representation and Correction of Gaussian Belief Propagation, proceedings of the International Conference on Machine Learning (ICL) '09, `http://www.cs.mcgill.ca/~icml2009/papers/543.pdf`, arxiv:0904.3769, co-authors: J. Johnson, V. Chernyak.

83. Planar Graphical Models which are Easy, submitted to JSTAT, arXiv:0902.0320, co-author: V. Chernyak.

82. Analysis of Error Floor of LDPC Codes under LP Decoding over the BSC, proceedings of ISIT 2009, co-authors: S.K. Chilappagari, M. Stepanov and B. Vasic.

81. Approximate inference on planar graphs using Loop Calculus and Belief Propagation, to appear in the Journal of Machine Learning Research, arXiv:0901.0786, co-authors: V. Gómez and H.J. Kappen.

80. Instanton-based Techniques for Analysis and Reduction of LDPC Error-floors, IEEE Journal on Selected Areas in Communications [Special issue on capaciyy approaching codes], **27**, 855-865 (2009), co-authors: S.K. Chilappagari, M. Stepanov and B. Vasic.

79. Irreversible Monte Carlo Algorithms for Efficient Sampling, arxiv:0809.0916, submitted to Physica D, co-authors: K. Turitsyn, M. Vucelja.

78. Fermions and Loops on Graphs. II. Monomer-Dimer Model as Series of Determinants, J. Stat. Mech. (2008) P12012, arXiv:0809.3481, co-author: V. Chernyak.

77. Fermions and Loops on Graphs. I. Loop Calculus for Determinant, J. Stat. Mech. (2008) P12011, arXiv:0809.3479, co-author: V. Chernyak.

76. Provably Efficient Instanton Search Algorithm for LP-decoding over the BSC, submitted to IEEE IT, arXiv:0808.2515, co-authors: S.K. Chilappagari and B. Vasic.

75. Belief Propagation and Beyond for Particle Tracking, arXiv: 0806.1199, co-authors: L. Kroc, M. Vergassola,

74. Reactive Rayleigh Taylor Turbulence, Journal of Fluid Mechanics **633** ,(2009), arXiv:0807.3772, co-authors: V. Lebedev, N. Vladimirova.

73. Belief Propagation and Loop Series on Planar Graphs, J. Stat. Mech (2008) P05003, arxiv:0802.3950, co-authors: V. Chernyak, R. Teodorescu.

72. Exactness of Belief Propagation for Some Graphical Models with Loops, J. Stat. Mech. (2008) P10016, arxiv:0801.0341

71. Non-equilibrium thermodynamics for functionals of current and density, arxiv:0712.3542, co-authors: V. Chernyak, S.V. Malinin, R. Teodorescu.

70. Reducing the Error Floor, invited talk at the Information Theory Workshop '07 on "Frontiers in Coding", September 2-6, 2007, arxiv:0706.2926.
69. Strong effect of weak diffusion on scalar turbulence at large scales, Physics of Fluids **19**, 101703 (2007), arxiv:0706.2928, co-authors: I. Kolokolov, V. Lebedev.
68. Self-Similarity and Universality in Rayleigh-Taylor, Boussinesq Turbulence, Physics of Fluids **21**, 015102 (2009), arXiv:0801.2981, co-author: Natalia Vladimirova.
67. Bethe-Free-Energy Based Decoding of Low-Density Parity-Check Codes on Partial Response Channels, submitted to Transactions on Communications, http://arxiv.org/abs/0904.0747, co-authors: J. A. Anguita, B. Vasic, and M. A. Neifeld.
66. Statistical geometry in homogeneous and isotropic turbulence, Journal of Turbulence **8**, 39 (2007), co-authors: Aurore Naso and Alain Pumir.
65. Searching for low weight pseudo-codewords, invited talk at the 2007 Information Theory and Application Workshop, proceedings ITA CALIT2, UCSD, cs.IT/0702024, co-author: Mikhail Stepanov.
64. Pseudo-codeword Landscape, Proceedings of ISIT 2007, June 2007, Nice, cs.IT/0701084, co-author: Mikhail Stepanov.
63. Loop Calculus and Belief Propagation for q-ary Alphabet: Loop Tower, Proceedings of ISIT 2007, June 2007, Nice, cs.IT/0701086, co-author: Vladimir Chernyak.
62. Dynamics of Energy Condensation in Two-Dimensional Turbulence, co-authors: C. Connaughton, I. Kolokolov and V. Lebedev, Phys.Rev.Lett. **99**, 084501 (2007).
61. Loop Calculus Helps to Improve Belief Propagation and Linear Programming Decodings of Low-Density-Parity-Check Codes, co-author: Vladimir Chernyak, invited talk at 44th Allerton Conference (September 27-29, 2006, Allerton,IL), arXiv:cs.IT/0609154.
60. Statistics of entropy production in linearized stochastic systems , co-authors: Konstantin Turitsyn, Vladimir Chernyak, Alberto Puliafito, Phys.Rev.Lett. **98**, 180603 (2007), nlin.CD/0609051.
59. Improving convergence of belief propagation decoding, co-author: Mikhail G. Stepanov, cs.IT/0607112, Proceedings of 44th Allerton Conference (September 27-29, 2006, Allerton, IL).
58. Path-integral analysis of fluctuation theorems for general Langevin processes, co-authors: Vladimir Chernyak and Christopher Jarzynski, cond-mat/0605471, JSTAT/2006/P08001.
57. Loop series for discrete statistical models on graphs, co-author: Vladimir Chernyak, cond-mat/0603189, JSTAT/2006/P06009.
56. Scale dependence of the coarse-grained velocity derivative tensor: influence of large scale shear on small-scale turbulence, Journal of Turbulence **7**, 41 (2006), co-authors: A. Naso, A. Pumir.
55. An Efficient Pseudo-Codeword-Search Algorithm for Linear Programming Decoding of LDPC Codes, arXiv:cs.IT/0601113, IEEE Transactions on Information Theory **54**, 1514 (2008), co-author: Mikhail Stepanov.
54. Loop Calculus in Statistical Physics and Information Science, Phys. Rev. E **73**, 065102(R) (2006), cond-mat/0601487, co-author: Vladimir Chernyak.
53. Instanton analysis of Low-Density-Parity-Check codes in the error-floor regime, arXiv:cs.IT/0601070, Proceeding of ISIT 2006, July 2006 Seattle, co-author: Mikhail Stepanov.
52. The error-floor of LDPC codes in the Laplacian channel, Proceedings of 43rd Allerton Conference (September 28-30, 2005, Allerton, IL), arXiv:cs.IT/0507031, co-author: Mikhail Stepanov.
51. Diagnosis of weakness in error correction: a physics approach to error floor analysis, Phys. Rev. Lett. **95**, 228701 (2005)+cond-mat/0506037 (long version), co-authors: Mikhail Stepanov, Vladimir Chernyak, Bane Vasic.
50. Dynamical generalization of non-equilibrium work relation, Phys. Rev. E **71**, 025102 (2005), co-authors V. Chernyak and C. Jarzynski.
49. Polymer Statistics in a Random Flow with Mean Shear, Journal of Fluid Mechanics **531**, 251-260 (2005), co-authors: Igor Kolokolov, Vladimir Lebedev and Konstantin Turitsyn.
48. Effects of surface tension on immiscible Rayleigh-Taylor turbulence, Phys. Rev. E **71**, 055301 (2005), co-authors: Igor Kolokolov, Vladimir Lebedev.
47. Error correction on a tree: An instanton approach , Phys. Rev. Lett. **93**, 198702-1 (2004), co-authors: Vladimir Chernyak, Mikhail Stepanov, Bane Vasic.
46. Outage probability for soliton transmission, Euro. Phys. Lett **66**, 499 (2004), co-authors: Vladimir Chernyak, Igor Kolokolov, and Avner Peleg.
45. Phenomenology of Rayleigh-Taylor Turbulence, Phys. Rev. Lett. **91**, 115001 (2003).
44. PMD induced fluctuations of Bit-Error-Rate in optical fiber systems, Journal of Lightware Technology **22**, 1155 (2004), co-authors: Vladimir Chernyak, Ildar Gabitov, Igor Kolokolov, and Vladimir Lebedev.
43. Periodic and Quasi-Periodic Compensation Strategies of Extreme Outages caused by Polarization Mode Dispersion and Amplifier Noise, JETP Lett. **78**, 198-201 (2003), http://arXiv.org/abs/physics/0303015, co-authors: Vladimir Chernyak, Igor Kolokolov, and Vladimir Lebedev.

42. Compensation for Extreme Outages caused by Polarization Mode Dispersion and Amplifier noise, Optics. Express. **11**, 1607 (2003), http://www.opticsexpress.org/abstract.cfm?URI=OPEX-11-14-1607, co-authors: Vladimir Chernyak, Igor Kolokolov, and Vladimir Lebedev.
41. Extreme Outages due to Polarization Mode Dispersion, Optics. Lett. **28**, 2159 (2003), co-authors: Vladimir Chernyak, Igor Kolokolov, and Vladimir Lebedev.
40. Probability of anomalously large Bit-Error-Rate in long haul optical transmission, Phys. Rev. E **68**, 066619 (2003), co-authors: Vladimir Chernyak, Igor Kolokolov and Vladimir Lebedev.
39. Passive Compensation of Polarization Mode Dispersion via Periodic Control of Birefringent Disorder, JOSA B 21, 486 (2004), co-authors: I. Gabitov, I. Kolokolov and T. Schäfer.
38. Inter-channel interaction of optical solitons, Phys. Rev. E 68, 026605 (2003), co-authors: A. Peleg and I. Gabitov.
37. Inelastic collisions of pulses in optical fibers, JOSA B **21**, 18 (2004), co-authors: A.Peleg and I. Gabitov.
36. Shedding and interaction of solitons in weakly disordered optical fibers, Phys. Rev. E. **67**, 036615 (2003), co-authors: Y. Chung, A. Dyachenko, I. Gabitov, I. Kolokolov, and V. Lebedev.
35. Boundary effects on chaotic advection-diffusion chemical reactions, Phys. Rev. Lett **90**, 134501 (2003), co-author: V. Lebedev.
34. Decay of scalar turbulence revisited, Phys. Rev. Lett **90**, 034501 (2003), co-author: V. Lebedev.
33. Pinning method of pulse confinement in optical fiber with random dispersion, JOSA B 19, 2538 (2002), co-authors: I. Gabitov, P. Lushnikov, J. Moeser, Z. Toroczkai.
32. Solitons in Optical Medium with Disorder and Anisotropy, Pis'ma v ZhETF **74**, 608 (2001), co-authors: I. Gabitov, I.Kolokolov, V. Lebedev.
31. Shedding and Interaction of Solitons in Imperfect Medium, Pis'ma v ZhETF **74**, 391 (2001) [JETP Letters **74**, 357 (2001)], co-authors: I. Gabitov, I.Kolokolov, V. Lebedev.
30. Pulse confinement in optical fibers with random dispersion, Proc. Natl. Acad. Sci. USA **98**, 14208 (2001), co-authors: I. Gabitov, J. Moeser.
29. The Lagrangian view of energy transfer in turbulent flow, Euro. Phys. Lett.**56**, 379 (2001), co-authors: A. Pumir, B. Shraiman.
28. Geometry of Lagrangian Dispersion in Turbulence, Phys. Rev. Lett.**85**, 5324 (2000), co-authors: A. Pumir, B. Shraiman.
27. Turbulence in Polymer Solutions, Proceedings of IUTAM 99 symposium on Geometry and Statistics of Turbulence, editors T. Kambe, T. Nakano and T. Miyauchi, Fluid Mechanics and Its application Bookseries, ISBN 0-7923-6711-1, Kluwer Academic Publisher, 2001.
26. Polymer Stretching by Turbulence, chao-dyn/9911011, Phys. Rev. Lett.**84**, 4761 (2000).
25. Small-scale turbulent dynamo, chao-dyn/9906030, Phys. Rev. Lett.**83**, 4065 (1999), co-authors: G. Falkovich, I. Kolokolov and M. Vergassola.
24. Lagrangian Tetrad Dynamics and Phenomenology of Turbulence, Physics of Fluids**11**, 2394 (1999), Co-authors: A. Pumir, and B. Shraiman.
23. Passive advection in nonlinear medium, chao-dyn/9809010, Physics of Fluids 11, 2257 (1999).
22. On how a joint interaction of two innocent partners (smooth advection & linear damping) produces a strong intermittency, chao-dyn/9803007, Physics of Fluids**10**, 3017 (1998).
21. Propagation of a Huygens front through turbulent medium, chao-dyn/9709028, Phys. Rev. Lett. **80**, 2837 (1998), Co-author: V. Yakhot.
20. Intermittent dissipation of a passive scalar in turbulence, chao-dyn/9709005, Phys. Rev. Lett. **80**, 2121 (1998), Co-authors: G. Falkovich, and I. Kolokolov.
19. Inverse versus direct cascades in turbulent advection, chao-dyn/9706016, Phys. Rev. Lett. **80**, 512 (1998), Co-authors: I. Kolokolov, and M. Vergassola.
18. Inverse cascade and intermittency of passive scalar in 1d smooth flow, chao-dyn/9706017, Phys. Rev. E **56**, 5483 (1997), Co-authors: I. Kolokolov, and M. Vergassola.
17. Instanton for random advection, chao-dyn/9606011, Phys. Rev. E **55**, 2722 (1997).
16. Non-universality of the scaling exponents of a passive scalar convected by a random flow, Phys. Rev. Lett. **76**, 3707 (1996), chao-dyn/9601016, Co-authors: G. Falkovich, and V. Lebedev.
15. Anomalous scaling exponents of a white-advected passive scalar, Phys. Rev. Lett. **76**, 2706 (1996), chao-dyn/9509007, Co-author: G. Falkovich.
14. Theory of random advection in two dimensions, Int. J. Mod. Phys. B **10**, 2273 (1996), Co-authors: G. Falkovich, I. Kolokolov, and V. Lebedev.
13. The fourth-order correlation function of a randomly advected passive scalar, JETP Lett **61**, 1012 (1995), chao-dyn/9508002, Co-authors: E. Balkovsky, I. Kolokolov, and V. Lebedev.

12. Normal and anomalous scaling of the fourth-order correlation function of a randomly advected passive scalar, Phys. Rev. E **52**, 4924 (1995), chao-dyn/9503001. Co-authours: G. Falkovich, I. Kolokolov, and V. Lebedev.
11. Equilibrium and nonequilibrium mean-field dynamics of quantum spin cluster., Sov.Phys.JETP **79**, 824 (1994), Co-author: I. Kolokolov.
10. Exact field-theoretical description of passive scalar convection in N-dimensional long-range velocity field, Phys.Lett.A **192**, 435 (1994), Co-authors: A. Gamba and I. Kolokolov.
9. Equilibrium dynamics of a paramagnet cluster, Phys.Rev.B **51**, 3974 (1995), Co-author: I. Kolokolov.
8. Statistics of a passive scalar advected by a large-scale 2D velocity field: analytic solution, Phys.Rev.E **51**, 5609 (1995), Co-authours: G. Falkovich, I. Kolokolov and V. Lebedev.
7. Passive scalar convection in a 2D long-range delta-correlated velocity field: exact results, Journ. of Phys. A **27**, 4925 (1994), Co-authors: Y. V. Fyodorov and I. Kolokolov.
6. Structural instability of two-dimensional turbulence, Physica D **78**, 11 (1994), Co-author: G. Falkovich.
5. Long-time dynamics of the infinite-temperature Heisenberg magnet, Phys. Rev. B **49**, 3592 (1994), Co-author: I. Kolokolov.
4. Functional integral and effective Hamiltonian t-J-V model of strongly correlated electron system, J. of Stat. Phys. **69**, 231 (1992), Co-author: V.I. Belinicher.
3. High-temperature phase of the 2D Couloumb gas model near the Kosterlitz- Thouless phase transition, Phys. Lett. A **162**, 402(1992).
2. The supersonic motion of a phase transition front, Sow. Solid. State **32**, 550 (1990), Co-author: A.Z.Patashinski.
1. The motion of a phase transition front in deep metastability, Sow. Solid. State **32**, 287 (1990), Co-author: A.Z.Patashinski.